Brain Hemisphere Synchronization and Musical Learning

Gregory D. Carroll
University of North Carolina at Greensboro

Brain Hemisphere Synchronization and Musical Learning

Teachers throughout the ages have struggled to maintain student concentration on the task at hand. The focusing of student attention is, of course, crucial to the learning process. Inattentive students are "attending", but not to the material being taught. They are confronted by a vast number of distractions, and sustained concentration frequently requires an extreme effort of will on their part. If wandering attention could be minimized, learning could be increased.

Research over the past decade has brought forth a tool that assists in focusing attention for various learning modalities. It is called Hemi-Sync, which is short for hemispheric synchronization of the brain. To date, there are no journal publications that discuss this particular technique. The National Research Council's Committee on Techniques for the Enhancement of Human Performance has recently initiated a two-year study of Hemi-Sync.

Hemi-Sync

Background

The Monroe Institute, located in Faber, Virginia, was founded in 1971 by its executive director, Robert A. Monroe, for the purpose of scientifically and systematically exploring expanded states of human awareness. Subject experimentation involved individuals who learned to control, sustain and deepen the hypnogogic state---the "twilight area" between normal waking consciousness and the sleep state. All too often, however, subjects would fall asleep and bring the research sessions to an abrupt halt!

In the mid-1970's, with the growing interest in brain hemisphere research and theory, The Monroe Institute developed a technique to assist in maintaining the elusive hypnogogic state, and found that this tool could be used to induce other states of consciousness as well, along a continuum from deep sleep to states of intolerable high anxiety. The significant aspects of this discovery were: (1) that the dominant brainwave patterns could be specifically changed by external stimuli, (2) that such changes in electrical activity produced their correlative physiological states, and (3) that there was a synchronicity---an equal balance in amplitude at discrete frequencies---of brainwave activity in both hemispheres.

The Phenomenon

Hemispheric synchronization of the brain is an unusual condition in which the electrical activity of the brain is balanced. Normally, right and left hemispheres generate signals that are often independent of each other. Synchronization is made possible by the brain's tendency to respond to a sustained difference frequency.

If a sound signal (sine wave) of a particular frequency is applied to one ear and a signal of a slightly different frequency is applied to the other, the halves of the brain must act in unison to "hear" a third signal, which is the difference between the two. For example, if one signal is 200Hz and the other is 210Hz, the signal generated is 10Hz.

If the difference between the two frequencies falls within the electrical response range of the brain, the brain "resonates" to this signal and increases the electrical intensity at or near this frequency. Such brain behavior is called Frequency Following Response (FFR). Researchers at The Monroe Institute suggest that there is an integration of brain hemisphere functioning due to this synchronization.

Combinations of binaurally-generated FFRs were explored for the purpose of fine-tuning brainwave activity in ways most appropriate to various learning modalities. The "appropriate" brain state most conducive to cognitive learning , for example, differs from the state most conducive to creativity. In subsequent research, Edrington and Panagiotides (1984) examines EEG responses to specific Hemi-Sync frequencies with (and without) pink noise masking and other auditory stimuli. Their studies assisted in developing the Hemi-Sync Synthesizer for classroom use.

The various mental/physical states (awake, drowsy, asleep, etc.) display their own characteristic brainwave patterns. Such psychophysiological correlates can be demonstrated on an EEG (an Electroencephalograph), a device which measures and records the electrical activity of the brain. For example, the normal waking state of awareness is typified by a dominance of electrical activity in the <u>Beta</u> frequency range (12-30+ Hz). In a relaxed, unfocused state, there is a reduction of beta intensity and an increase in <u>Alpha</u> (8-12 Hz). During sleep there is a rise in amplitude of <u>Theta</u> (4-8Hz) and <u>Delta</u> (.5-4 Hz).

Many theories have been postulated to explain the relationship between learning behavior and brainwave activity. There is apparent inconsistency in the claim that theta is the optimal learning state and beta the optimal problem-solving state. Other research suggests that beta involves critical and judgmental thinking, whereas theta is highly receptive and uncritical.

Theta is the most difficult of the four EEG ranges to control and sustain. A theta FFR produces deep relaxation, but often induces delta sleep. Superimposing a beta FFR above the theta brings about <u>relaxed alertness</u>. This combination of signal sets is one of the more appealing for classroom learning.

<u>Previous Educational Applications</u>

In a general psychology class, Edrington (1983) found that students listening to cognitive material with Hemi-Sync background signal ($4 \pm .2$ Hz) scored significantly higher than the control group on five of six tests. The verbal information on the tapes were definitions and terms peculiar to the discipline of psychology.

At a government training school, Waldkoetter (1982a) found Hemi-Sync to focus and hold attention. Mental-motor skills were increased by 75%. In another study, Waldkoetter (1982b) found that Morse code students improved their ability by as much as 30%.

The use of Hemi-Sync with developmentally disabled children has been proven to be of particular therapeutic value. Morris (1985) observed that "hopeless" retarded-autistic children were able to achieve motor and learning growth significantly beyond the norm in both quality and speed of development.

The Study

Subjects

The subjects were forty first-semester freshman ear training students enrolled in the 1984 Fall Semester at UNC-Greensboro who volunteered to participate. The last four digits of their social security numbers were used to identify and randomly separate the subjects into control and experimental groups.

Hypothesis

The intent of the study was to determine the effectiveness of Hemi-Sync in accelerating aural recognition of musical intervals. The hypothesis was that students listening to a taped lecture/demonstration with a masked 4 Hz difference frequency would develop a better ability to identify musical intervals than those students without the difference signal.

Procedure

All participating subjects were asked to listen to a forty-minute cassette tape at six different times. The tapes contained a pretest, a lecture/demonstration, and a posttest. All tapes were identical, except for the masked Hemi-Sync signal on the experimental group's tapes.

The pretest and posttest each contained fifteen intervals for identification. Five intervals were harmonic, five were melodic-up and five were melodic-down. Each interval was heard twice. The pitch range for the intervals performed was G to F#.[2] The intervals were equally divided within the range to minimize any gender bias.

The study was administered by the staff of the Music Listening Center in the School of Music in a double-blind setting. Multiple copies of the tapes were coded and distributed to the subjects. Files were maintained for each subject and each scoresheet was identified by a session number. Once the study was completed, the data was analyzed by the university's Academic Computer Center.

Results

Statistical analysis did not show significant group differences in learning from session to session. However, subjects in the experimental group achieved higher posttest scores in 54% of their sessions, in contrast with control-group subjects who performed better on their posttests in only 28% of their sessions (see Table 1). Mean scores for individual subjects also imply a difference between both groups (see Table 2). This suggests that Hemi-Sync assisted in maintaining subject attention through the course of each session, which is consistent with the conclusions of Owens (1984), Edrington (1983) and Waldkoetter (1982a).

One particular aspect of the study has lead to inconclusive results. The presence of the difference frequency on the experimental group's tapes appears to have interfered with the identification of the perfect octave. (The harmonic octave was frequently identified as a minor sixth.) The effect it might have had on the other interval identifications is unknown. Perhaps with more efficient masking, the results may have shown a significant difference between the groups.

There is no concrete evidence to show that the subjects' brainwaves actually responded to the signals. It was mechanically impossible to monitor their sessions with a dual-trace EEG. Such limitations should not pose a problem in research if changes in learning behavior are the basis for research conclusions.

Implications for Further Use and Research

The forgoing study begs for further examination of Hemi-Sync in a variety of contexts. The Hemi-Sync Synthesizer, designed for classroom use, requires a minimum of equipment (a pair of speakers or stereo headphones, a cassette player and cassette tapes for masking) and no special facilities. Four optional setting are available to the researcher: Relaxation (theta mixed with delta), Imaging and Affective Learning (theta), Imaging and Attention (theta mixed with beta), and Attention Focusing - Cognitive Learning (theta mixed with delta and beta).

The Imaging and Attention setting would be appropriate to music theory and music appreciation, for which auditory imagery is central. The Attention Focusing - Cognitive Learning setting would also be appropriate to music theory, as well as music history, private lessons and practice on one's instrument. (Different kinds of masking may be necessary when music is being listened to.)

Wagner and Altman (1984) have explored biofeedback as a tool to assist in musical learning. They state that brainwave control may be effectively used in the music classroom if there were greater personal control over one's consciousness/attentiveness level. Hemi-Sync takes biofeedback a large step forward in achieving this level of "control", because individuals do not have to undergo the lengthy entrainment sessions required by the biofeedback model. Also, these particular brain-states can be learned and reproduced more quickly through on-task utilization.

Subjective observations (Carroll 1986) indicate that students are conditioned very quickly to respond to the classroom environment itself, and enter into the focused state even when the signals are not present.

Pre-performance anxiety may be minimized by exposure to theta mixed with delta. This combination accelerates the calming process. Owens (1984) reports it is effective in calming students who have come from the playground or an activity involving considerable sensory stimulation. (Owens affectionately refers to this setting as "stun!") As part of a pre-performance process, the use of theta and positive imaging of the future performance itself may be beneficial.

As cited earlier, the research of Morris (1985, 1986) using music and Hemi-Sync bears directly upon the field of music therapy. Morris has found this combination to be a powerful guide in learning and healing.

Music education (and education in general) has come to a new and fascinating horizon. The application of Hemi-Sync within the various areas of music is, virtually, uncharted research territory. Future study of this phenomenon may have a profound impact upon music learning in a variety of settings. Potential avenues for its use are limited only by the creativity and interest if the researcher.

References

Carroll, G.D. (1986, April). Hemi-Sync and musical interval identification. Paper presented at the annual meeting of the College Music Society, Mid-Atlantic Chapter and the Southeast Chapter of the American Musicological Society, Winston-Salem, NC.

Edrington, D. (1983, January). Hypermnesia experiment. Breakthrough. (Available from The Monroe Institute, Rt. 1, Box 175, Faber, VA 22938)

Edrington, D. & Panagiotides, H. (1984) [EEG responses to auditory stimuli]. Unpublished raw data.

Morris, S.E. (1985, October). Facilitation of learning: The use of music and Hemi-Sync with children with developmental disabilities. Paper presented at the professional seminar of The Monroe Institute, Faber, VA.

Morris, S.E. (1986, August). Music and Hemi-Sync: Impact on learning. Paper presented at the professional seminar of The Monroe Institute, Faber, VA.

Owens, J.D. (1984). Some reports from teachers using Hemi-Sync. Unpublished manuscript, Tacoma Community College, Tacoma, WA.

Wagner, M.J., & Altman, R. (1984). Music learning and brainwave biofeedback. Update, 2(3), 19-23.

Waldkoetter, R. (1982a). Executive summary. Unpublished manuscript, The Monroe Institute, Professional Division, Faber, VA.

Waldkoetter, R. (1982b). The use of audio guided stress reduction to enhance performance. Unpublished manuscript, The Monroe Institute, Professional Division, Faber, VA.

Table 1

Comparison of Individual Session Score Changes

Group	n	Positive	Negative	No Change
E	114	62 (54.4%)	39 (34.2%)	13 (11.4%)
C	109	31 (28.4%)	56 (51.4%)	22 (20.2%)

Table 2

Comparison of Individual Subject Means

Group	n	Positive	Negative	No Change
E	21	14 (66.7%)	4 (19.0%)	3 (14.3%)
C	19	6 (31.6%)	13 (68.4%)	